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ABSTRACT

To examine intra- and interhemispheric communication or the transfer of information within and between the cerebral hemispheres, 32 right-handed learning disabled children aged 8-10 years, 11-13 years, and 14-16 years were presented a tactile discrimination task. Fabrics of the same or different texture were presented to the same hand (uncrossed condition) or alternating hands (crossed condition). A repeated measures design was used to investigate performance on the tactile task using a verbal response mode and a nonverbal response mode. Analyses indicated the number of uncrossed errors and crossed errors were significantly greater for the verbal response mode as compared to the nonverbal response mode. The youngest children made significantly more crossed errors in the verbal response mode compared to the nonverbal response mode. Results suggested that younger learning disabled children may experience greater difficulty using a verbal response mode on a task which is inferred to require interhemispheric transfer of information. (Author/CL)

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INTERHEMISPHERIC TRANSFER OF TACTILE INFORMATION BY LEARNING DISABLED CHILDREN

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ABSTRACT

A sample of 32 right-handed, learning disabled children aged 8-10 yr., 11-13 yr., and 14-16 yr. were presented a tactile discrimination task. Pairs of fabrics of the same or different texture were presented to the same hand (Uncrossed condition) or alternating hands (Crossed condition). The Uncrossed hand condition and the Crossed hand condition are inferred to relate to intra- and interhemispheric processing or the transfer of information within and between the cerebral hemispheres. A repeated measures design was used to investigate the performance on the tactile discrimination task using a Verbal Response Mode and a Nonverbal Response Mode. Analyses indicated the number of Uncrossed errors and Crossed errors were significantly greater for the Verbal Response Mode as compared to the Nonverbal Response Mode. In addition, the youngest learning disabled children (8-10 yr. olds) made significantly more Crossed errors in the Verbal Response Mode as compared to the Nonverbal Response Mode. These results suggest that younger learning disabled children may experience greater difficulty using a Verbal Response Mode on a task which is inferred to require interhemispheric transfer of information.

Traditionally, studies of learning disabled children and cerebral processing have focused upon delays, deficits, or incomplete cerebral lateralization. As early as 1937, Orton suggested an association between learning difficulties and abnormal cerebral dominance. Subsequent studies have shown a neural maturational lag in the development of the left hemisphere (Satz & Sparrow, 1970) or a deficit in the processing of linguistic information in the left hemisphere (Pirozzolo & Rayner, 1979). Witelson (1977a, 1977b), while recognizing left hemisphere dysfunction of learning disabled children, attributed this situation to bilateral representation of spatial functions. In contrast, Dean (1980) and Dean, Schwartz, and Smith (1981) proposed bilaterality of verbal function which results in "cerebral confusion." Cross-lateralization or ill-established dominance was also suggested by Wheeler, Watkins, and McLaughlin (1977).

Theoretical and experimental reports relating learning problems and cerebral lateralization are conflicting and inconsistent. An extensive review of the research literature questions the linkage between reading disability and lateral asymmetry. Naylor (1980, p. 537) concludes that:

> The dichotic and dichhaptic studies like the visual half-field studies, do not support the hypothesis that reading disability is related to incomplete or inconsistent cerebral asymmetry.

In contrast, other dichotic listening studies (Hynd, Obrzut, Hynd, & Conner, 1978; Obrzut, Hynd, Obrzut, & Pirozzolo, 1981)

have reported evidence of attentional deficits in learning disabled children. During listening tasks involving simultaneous processing, learning disabled subjects showed a great susceptibility to attentional bias and "... performed as if there were minimal interaction between the two cerebral hemispheres in processing the dichotic stimuli" (Obrzut, et. al., 1981, p. 123). A deficit in callosal functioning or the ability to transfer information between the hemispheres by learning disabled children has been proposed by Badian and Wolff (1977), Berlin, (1985), Hynd, Obrzut, Weed, and Hynd (1979), Neff (1986), Obrzut, Hynd, Obrzut, and Leitgeb (1980), and Obrzut, Hynd, Obrzut, and Pirozzolo (1981).

This study was designed to investigate the effect of Response Mode (Nonverbal and Verbal) on Uncrossed and Crossed hand condition errors on a tactile discrimination task for three age levels (8-10 yr., 11-13 yr., and 14-16 yr.) of learning disabled children. Uncrossed and Crossed hand conditions are inferred to relate to intra- and interhemispheric communication or the transfer of information within and between the cerebral hemispheres.

METHOD

Sample

Subjects were volunteers from three special classrooms in elementary and junior high schools in an urban, white, middle-class school district. Thirty-two students were identified as

learning disabled and placed in these special classrooms according to state guidelines. These guidelines prescribe a multifactored evalulation based upon measures of general intelligence, academic performance in reading and mathematics, communicative status, vision, hearing, and motor abilities, and social and emotional status. Special classes are required if there is a severe discrepancy between intellectual ability and achievement.

All subjects were right-handed as determined by the use of the same hand for the performance of 10 out of 12 simple tasks such as drawing, writing, throwing a ball, brushing teeth, combing hair, etc. These 12 tasks were selected from an handedness questionnaire developed by Raczkowski, Kalat, and Nebes (1974). The sample of 32 subjects was distributed across three age levels. The three age levels were 8 to 10 yr. old (7 boys, 3 girls), 11 to 13 yr. old (8 boys, 3 girls) and 14 to 15 yr. old (10 boys, 1 girl). Table 1 shows the Response Mode by Age sample distribution.

Table 1. Response Mode by Age Sample Distribution

		Response Mode		
Age		Verbal	Nonverbal	Total
8-10	n	10	10	10
11-13	n	11	11	11
14-16	n	11	11	11
Total	n	32	32	32

Treatment

A tactile discrimination task involving two pillows of the same fabric (same) or two different fabrics (not same) were sequentially presented to either the same hand (Uncrossed condition) or the opposite hand (Crossed condition). Four small pillows were made of various textured fabrics (e.g., plastic, velvet, felt). There were four sets of four pillows varying in difficulty of discrimination: easy, medium easy, medium difficult, difficult. These materials were the same as those used by Galin, Johnstone, Nakell, and Herron (1979). Students were screened as to their understanding of "sameness," pretested for difficulty with regard to the set of pillows (to assure consistent relative difficulty across age levels), and instructed as to the task according to the procedures used by Galin, et al. (1979).

This task was selected for this study as it is identified as a simple, low level tactile discrimination task. It was selected based upon the evidence (Galin, Diamond, & Herron, 1977; Galin, et al., 1979; Languis, Strausbaugh, Clapham, & McCarthy, 1981) that five year old normal children did not make significantly more Uncrossed hand errors as compared to Crossed hand errors. This was interpreted to infer no significant difference between the intra- and interhemispheric transfer of information for this task for normal five year olds.

Procedure

At the start of each test session, subjects were visually presented the appropriate set of four pillows. The subjects were then asked to close their eyes and place their hands in a curtained box out of subject's view. The experimenter tactually stimulated the fingers of one hand (proximal to distal) and then used either the same pillow or another textured pillow to stimulate the same hand (Uncrossed hand condition) or the opposite hand (Crossed hand condition). The subject was asked to discriminate between the pillows by verbally responding "same" or "not same" to the successive stimulations (Verbal Response Mode). The treatment was administered so that there were a total of 64 trials in four treatment sets with a rest period between each treatment set. Each set involved varying the stimulation of the hand as follows: LL-LR-RR-RL-RL-RR-LR-LL and LL-LR-RR-RL-RL-RR-LR-LL. There were 32 trials involving the Uncrossed hand condition and 32 trials involving the Crossed hand condition. There were equal numbers of discriminations involving pillows of the same fabric and pillows of different fabrics. The number of discriminations involving pillows of different fabrics was equally distributed across the 64 trials.

Twenty to thirty days later, the Nonverbal Response Mode treatment session commenced. The procedure for the Nonverbal Response Mode treatment session was identical to the previous Verbal Response Mode procedure except that the subjects were instructed to nonverbally respond, i.e., shake your head

up-and-down when the fabrics were the same and from side-to-side when the fabrics were not the same.

Data Analysis

The data was analyzed by a Response Mode (Verbal, Nonverbal) and Age (8-10 yr., 11-13 yr., 14-16 yr.) repeated measures multivariate analysis of variance. The Uncrossed and Crossed raw errors (summed over 64 trials) were analyzed by the multivariate analysis of variance using the Wilk's Lambda statistic to examine the effects of Response Mode and Age on errors. Univariate analyses of variance were computed as followup to these effects. The dependent variables in these analyses were Uncrossed raw errors (inaccurate discrimination on trials in the Uncrossed hand condition) and Crossed raw errors (inaccurate discriminations in the Crossed hand condition). Post hoc comparisons were made using Scheffe's procedure. Differences with an Alpha $\leq .05$ were considered statistically significant in all analyses.

RESULTS

Tables 2 and 3 show the means and standard deviations for the Uncrossed and Crossed hand condition errors on the tactile discrimination task by Response Mode by Age.

Table 2. Means and Standard Deviations for Uncrossed Errors

Age		Response Mode: Verbal	Nonverbal
8-10	M	9.70	7.50
	SD	3.43	4.09
11-13	M	7.91	6.82
	SD	4.44	3.28
14-16	M	7.73	6.54
	SD	3.16	2.66
Total	M	8.41	6.94
	SD	3.71	3.28

Table 3. Means and Standard Deviations for Crossed Errors

Age		Response Mode: Verbal	Nonverbal
8-10	M	10.80	6.70
	SD	4.21	3.80
11-13	M	7.18	5.91
	SD	4.51	3.05
14-16	M	7.46	7.73
	SD	2.34	2.33
Total	M	8.41	6.78
	SD	4.02	3.09

Tables 4, 5, and 6 show the results of the multivariate and univariate analyses of variance.

Table 4. Repeated Measures Multivariate Analysis of Variance of Uncrossed and Crossed Errors for Response Mode by Age

Source	df	F	p
Between Subjects			
Wilk's Lambda			
Age	4/56	1.28	.29
Within Subjects			
Response Mode	2/28	3.68	.04*
Response Mode by Age	4/56	1.66	.17

Table 5. Repeated Measures Univariate Analysis of Variance of Uncrossed Errors for Response Mode by Age

Source	df	MS	F	p
Between Subjects				
Within Cells	29	19.00		
Age	2	12.81	.67	.52
Within Subjects				
Within Cells	29	6.24		
Response Mode	1	35.49	5.68	.02*
Response Mode by Age	2	1.96	.31	.73

Table 6. Repeated Measures Univariate Analysis of Variance of Crossed Errors for Response Mode by Age

Source	df	MS	F	p
Between Subjects				
Within Cells	29	16.19		
Age	2	25.46	1.57	.23
Within Subjects				
Within Cells	29	7.78		
Response Mode	1	46.15	5.93	.02*
Response Mode by Age	2	25.56	3.29	.05*

Inspection of these analyses show the following significant results:

1. Across age levels the subjects made more Uncrossed and Crossed errors combined in the Verbal Response Mode than in the Nonverbal Response Mode [multivariate Response Mode effect ($F_{2,28} = 3.68$, $p \leq .04$)].

2. Across age levels the subjects made more Uncrossed errors in the Verbal Response Mode than in the Nonverbal Response Mode [univariate Response Mode effect ($F_{1,29} = 5.68$, $p \leq .02$)].

3. There was an interaction between Response Mode and Age for Crossed errors (univariate Response Mode by Age interaction effect [$F_{2,29} = 3.29$, $p \leq .05$)].

The Response Mode by Age cell means for Crossed errors are plotted in Figure 1 to facilitate the interpretation of this interaction.

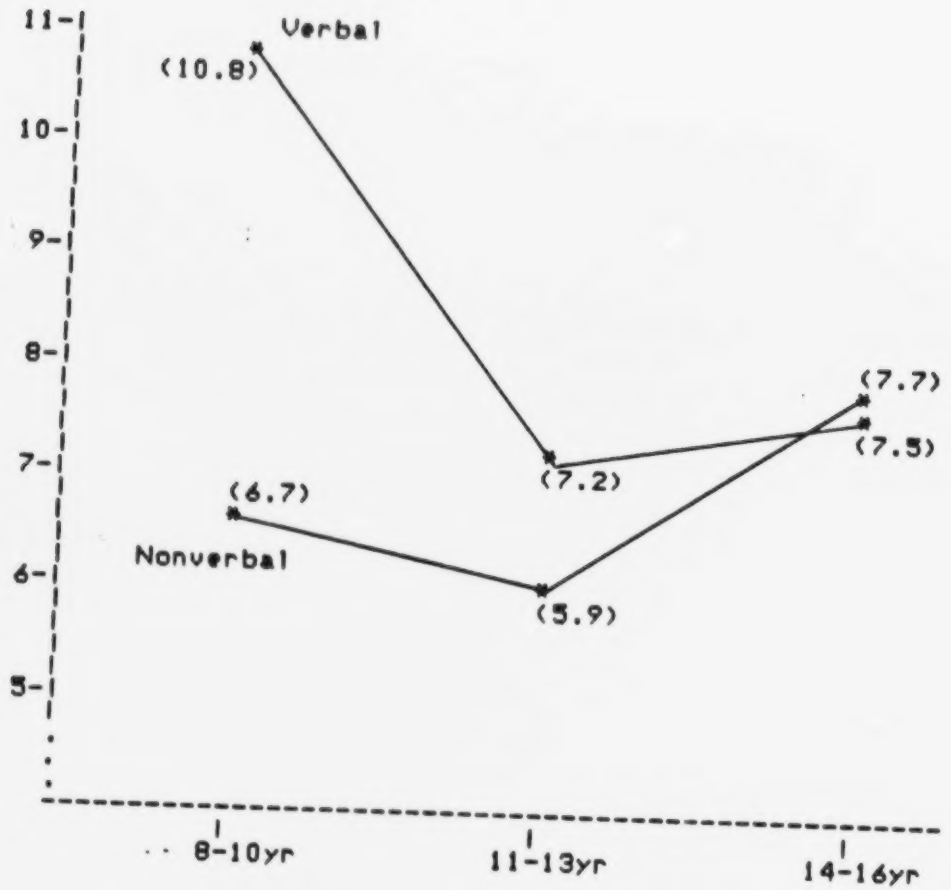

Figure 1. Response Mode by Age Interaction for Crossed Errors

Scheffe' post hoc multiple comparisons (Glass & Stanley, 1970, pp. 388-393) were computed to determine the nature of the Response Mode by Age interaction for Crossed errors. Contrasts were developed to provide insight into the following questions:

#1. How do 8-10 yr. old Verbal and Nonverbal Response Mode Crossed errors compare?

#2. How do 11-13 yr. old Verbal and Nonverbal Response Mode Crossed errors compare?

#3. How do 14-16 yr. old Verbal and Nonverbal Response Mode Crossed errors compare?

Table 7 summarizes the Scheffe' tests of significance on these contrasts.

Table 7. Scheffe' Post Hoc Multiple Comparisons for Response Mode by Age Interactions for Crossed Errors

Contrast #	Critical Contrast Value ($p \leq .05$)	Contrast Value
1	3.9	4.1*
2	3.8	1.3
3	3.8	-0.2

* = $p \leq .05$

The results of the Scheffe' contrast comparisons indicate that the number of Crossed errors for 8-10 yr. olds is significantly higher ($p \leq .05$) in the Verbal Mode than in the Nonverbal Mode (contrast #1). Similar differences were not evidenced for 11-13 yr. olds or 14-16 yr. olds (contrasts #2 and #3.) The 8-10 yr. olds made more Crossed errors than the 11-13 and 14-16 yr. olds in the Verbal Response Mode.

DISCUSSION

Previous research (Berlin, 1985) revealed that in the Verbal Response Mode, 8-10 yr. old learning disabled children made significantly more Crossed hand condition errors using this same tactile discrimination task than either 11-13 or 14-16 yr. old learning disabled children. The results in the present study indicate that the Age effect is now confounded by the Response

Mode effect. The 8-10 yr. old learning disabled children made significantly more Crossed hand condition errors in the Verbal Response Mode than in the Nonverbal Response Mode. These differences were not found in the two groups of older learning disabled children (11-13 and 14-16 yr. olds). Possible explanations for the differential effects for the 8-10 yr. old learning disabled children include:

1. an increased demand for interhemispheric transfer of information in the Verbal Response Mode which is more detrimental to this group;
2. a deficit in verbal encoding and the use of language;
3. a Nonverbal Response Mode bias;
4. selective attention susceptibility which inhibits interhemispheric collaboration; or
5. a developmental delay in both left hemisphere language lateralization and callosal functioning which serve to inhibit selective attentional biases (Kinsbourne, 1974).

More research using these tactile discrimination tasks as well as other similar tactile tasks is suggested. Additional subjects should include both normal and learning disabled children and be representative of various ages. This research might improve understanding, explain the relationship of Age, the effect of Response Mode, and more precisely identify the critical age for the development of interhemispheric transfer of this type of tactile information. It would be appropriate to utilize other sense modalities (e.g., auditory, visual) to determine the generalizability of children's performance on tasks inferred to involve interhemispheric transfer of information.

EDUCATIONAL IMPLICATIONS

While it is recognized that most cognitive tasks require the information processing of both hemispheres, the results of this study have implications for instructional strategies for learning disabled children. It is suggested that interhemispheric communication in the initial stages of concept learning be minimized. Effective teaching strategies could focus upon stimuli and responses that require similar modes of hemispheric processing. Based upon a possible verbal encoding and language deficit or a developmental delay in linguistic lateralization for young learning disabled children, right hemisphere processing modalities are initially recommended. For example, stimuli could consist of images, pictures, auditory signals, models, or concrete objects while responses could be drawn, pointed to, touched, composed, constructed, or manipulated. Reinforcement and extension of learning could then incorporate the left hemisphere processing skills which employ verbal or symbolic stimuli and responses.

These educational suggestions are further supported by the work of Van den Honert (1977). She found that 7th grade dyslexic children could be successfully lateralized by means of auditory, visual, and tactile procedures. These right hemisphere intervention strategies resulted in an average gain of four years. Additional research directed toward classroom application might focus upon the performance of learning disabled children

and the use of different instructional strategies designed to promote either intra- or interhemispheric processing.

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